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ORIGINAL INVESTIGATION

Do Meteorological Changes Have an Effect on The Occurence of Spontaneous Pneumothorax?

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Abstract

OBJECTIVES: Spontaneous pneumothorax refers to the leakage of air into the space between the parietal and the visceral layers of the pleura. It occurs with or without a known lung disease. We aimed to investigate the effects of atmospheric pressure, humidity, and temperature changes on the incidence of spontaneous pneumothorax (SP).

MATERIAL AND METHODS: This study included 551 patients with spontaneous pneumothorax retrospectively screened between January 2009 and December 2013. The medical data of the patients were accessed via their medical records on the hospital automation system. The atmospheric pressure, temperature, humidity rate, amount of precipitation, and wind velocity on the day of spontaneous pneumothorax were obtained from the data provided by the general directorate of meteorology. The three consecutive days on which at least 2 cases of SP presented were collectively considered as a cluster. The study data were analyzed with the SPSS version 15 software package, using the Chi-square and the Student's t tests. A p value less than 0.05 was considered statistically significant.

RESULTS: Of the 552 patients included in the study, 89.3% had primary spontaneous pneumothorax and 10.7% had secondary spontaneous pneumothorax. Ninety-two percent of the patients were male and 8% were female. The mean age was 24 years. Clustering was observed in 71.7% of the study population. No significant differences were observed between yearly and monthly SP incidences. There were, however, differences between the days with SP and the days without SP with respect to atmospheric pressure, ambient temperature, wind velocity, and humidity rate. The differences between the atmospheric pressures were not statistically significant, although the differences between the ambient temperature and the humidity rate were statistically significant ($p \leq 0.05$).

CONCLUSION: We determined that the changes in the ambient temperature and the humidity rate affected the rate of spontaneous pneumothorax by altering the meteorological conditions.

KEYWORDS: Atmospheric pressure, temperature, pneumothorax-humidity, amount of precipitation, spontaneous

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INTRODUCTION

The term pneumothorax was first used by Itard followed by Laennec in 1803 and 1819, respectively [1]. The term spontaneous pneumothorax refers to the leakage of air of any cause into the space between the parietal and the visceral layers of the pleura [2]. It has primary and secondary types. The primary spontaneous pneumothorax (PSP) occurs without a known lung disease whereas the secondary spontaneous pneumothorax (SSP) occurs in persons with underlying lung pathology [3]. Unlike the PSP, the SSP is related to the underlying lung pathology although tuberculosis is no longer the most common underlying pathology in the developed world. The consequences of pneumothorax are more severe and generally difficult-to-treat in persons with previous lung disease [4].

The most common cause of the PSP is the tearing of the apical subpleural blebs. The affected patients are typically young, tall, and thin males. Some authors have linked the high rate of incidence of the PSP in those patients to a higher apical pleural negative pressure. The SSP variety, on the other hand, usually occurs due to an underlying lung disorder, such as obstructive lung disease, tuberculosis, immune deficiency syndromes, sarcoidosis, pneumonia, or cystic fibrosis [5]. Some authors have hypothesized that there is a prominent link between the SP rate and low humidity in that the bronchoconstriction occurring during humidification of dry air inside the airways may play a role in the

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physiopathology of pneumothorax and thus atmospheric pressure changes as well as humidity and increased temperature may increase SP rate [6-9].

We investigated the effects of the meteorological changes including atmospheric pressure, humidity, and temperature changes on the incidence of spontaneous pneumothorax (SP) in a continental climate.

MATERIAL AND METHOD

After obtaining the approval of our university's local ethics committee, we retrospectively studied the patients who presented to the departments of emergency medicine and chest surgery and were diagnosed with SP between January 2009 and December 2013. The patients in whom a tube thoracostomy procedure was not performed (those with minimal pneumothorax) were excluded. Minimal pneumothorax cases, which are radio occult on chest X-Rays, were treated with oxygen support and did not undergo any surgical intervention including needle aspiration. The 551 patients included in the study were analyzed through hospital records with regard to exposure to cigarette smoke, clinical properties, and comorbidities. The clinical properties of the patients who underwent tube thoracostomy or, after tube thoracostomy failure, video-assisted thoracoscopic surgery or axillary thoracotomy were studied. Treatment options in pneumothoraces were not compared in this study.

The general directorate of Meteorology provided the meteorological variables including the daily atmospheric pressures (hPa), temperature levels, humidity rate, amount of precipitation, and wind velocity on the days of patient presentations. As of the date of the study, there were 14 reading stations in our geographical region. According to the information provided by the local authorities, all meteorological data were analyzed under similar conditions and in similar stations. The data in question included temperature readings in centigrade (C°) degrees, daily average pressure (hPa) in millibars, daily average humidity in percentage (%), the amount of precipitation in millimeters, daily maximum wind velocity in m/sec and wind direction in direction name. In addition, the minimum values of the atmospheric pressure, temperature, and humidity rate were substracted from the maximum values of the same parameters to calculate the maximum-minimum difference. Then, based on the day of hospital presentation of 551 patients, we compared the daily atmospheric pressure, temperature readings, humidity rates, the amount of precipitation, and the wind velocities of that day. The three consecutive days on which at least 2 cases of SP presented were collectively considered as a cluster and the meteorological events at the clustering days were recorded.

Statistical Analysis

The meteorological data were analyzed with the SPSS version 15 software package (SPSS Inc. Chicago, Illinois, USA), using the Chi-Square and the Student's t tests. The demographic variables of the patients were analyzed using the Chi-Square and the Student's t tests. A p value less than 0.05 was considered statistically significant. Logistic regression analysis was conducted to investigate the association between the occurrence of pneumothorax and meteorological variables.

RESULTS

The mean age of the study population was 23.96 ± 9.28 years and 92% were male (Figure 1). PSP was present in 89.3% of the patients and SSP in the rest. The disease predominantly affected males (92%). PSP was most commonly seen in the second decade while SSP was more common in those aged over 40 years. Males had SP at earlier ages than their female counterparts. Among the PSP group, pneumothorax was right-sided in 252 (45.65%) patients and left-sided in 240 (43.47%) patients; the difference between the number of right- and left-sided pneumothoraces in PSP and SSP was not statistically significant (p= 0.95); and the proportion of smokers (n= 492, 89.3%) were much more in number than non-smokers (n= 59, 10.7%), and the difference between the two groups was not significant (p= 0.07) (Figure 1).

There were no significant differences between the monthly and yearly distribution of the pneumothorax cases during the years 2009-2013. The cases were the least common in winter (n= 130) and fall (n= 131) and the most common in summer (n= 147) and spring (n= 140). Sorted by month of incidence, the highest number of cases occurred in September (n= 55), followed by May and July (n= 54 for each), while the least number of cases occurred in January (n= 38) and November (n= 39). Other months had very similar number of cases (Figure 2). Significant differences were found between the patients with respect to age and gender (p< 0.001). As the patients were retrospectively assessed, the day of SP incidence was accepted as the day of hospital presentation. Clustering was observed in 71.7% of the patients. A cluster contained 2.82 patients on average. Clusters occurred during or after decreasing in humidity. There was an association between days with pneumothorax and days on which ambient temperature rised.

The days with SP incidents had significantly different atmospheric pressure, ambient temperature, wind velocity, and humidity rate when compared to the days without SP (p< 0.05). The amount of precipitation and the difference between the maximum and minimum atmospheric pressure were not significantly different at the days with SP incidents

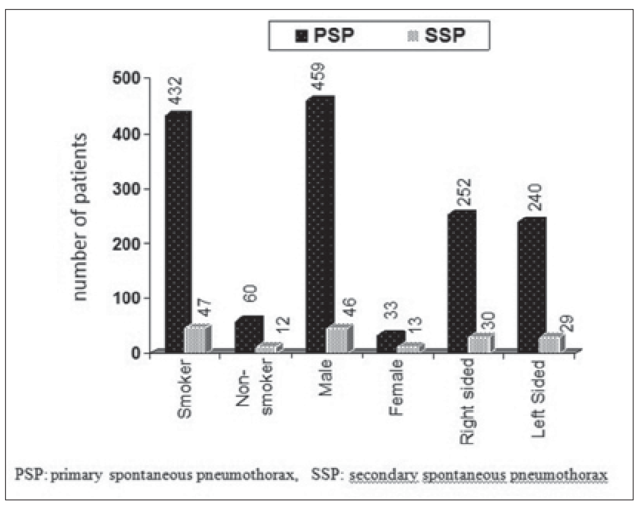

Figure 1. The demographic and clinical characteristics of the pneumothorax cases.

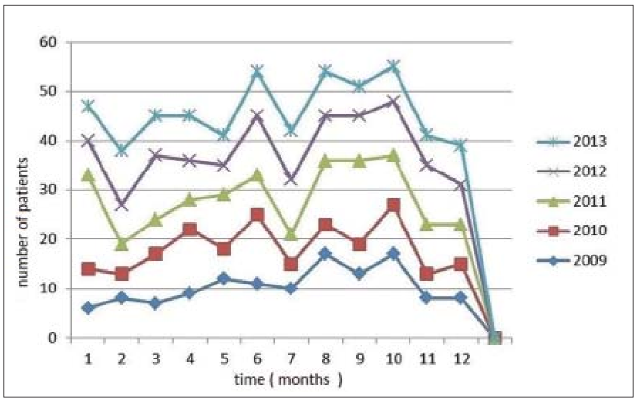

Figure 2. Number of pneumothorax cases by month during the years 2009 to 20013.

(p≥ 0.05). The minimum and maximum temperatures were significantly different ($p < 0.05$). The mean temperature rise and the humidity rate were significantly different between the groups ($p < 0.05$). The meteorological conditions of the day before the day of SP incidence were also not significantly different (Table 1). Table 2 shows factors associated with pneumothorax occurrence. R2 value was 0.276 and statistically significant ($p < 0.001$).

DISCUSSION

Incidence of pneumothorax is around 18-28/100.000 in men and 2-6/100.000 among women [3,7]. In our study, 92% of the patients were male and the rest were female. Unlike PSP, SSP is related to the underlying lung pathology; however, tuberculosis has lost its top place among the causative conditions in developed world. The clinical outcomes are graver and the treatment poses more challenges in patients with previous lung disorders [4]. In our study the PSP patients had no underlying lung pathology but most of those with SSP had chronic obstructive pulmonary disease or tuberculosis. Smoking was considered as the most common etiological agent. While the smoking habit was related to a pneumothorax risk of 12% in healthy men, it was 0.1% in non-smokers [10]. In our study 492 males were smokers. The rate of smoking was high among both smokers and non-smokers, albeit statistically non-significant.

Spontaneous pneumothorax develops secondary to some factors that induce rupture of bullae and blebs in persons with no known disease. There is, however, no consensus as to the causes that precipitate SP incidence and increase the number of SP cases. Transpulmonary pressure gradient leads to air entrapment and development of SP. A sudden change in pressure may cause SP during flight or diving. Many former studies have investigated the impact of meteorological variables (atmospheric pressure, ambient temperature, amount of precipitation, humidity rate, and wind velocity) on the incidence of SP [7,11]. A clustering pattern of the hospital presentations of the SP cases have led to scrutinization of the climate and weather conditions. It has been suggested that the undulation of the weather conditions cause weakening of the walls of small air cysts in lungs. However, we obtained results similar to some other trials that have reported no relationship between SP incidence and seasons, months [7]. SP occurs in episodes and clusters [11,12]. More than 2 cases in 3 consecutive days are considered a cluster of cases [7,12]. We found a clustering rate of 71.7% in our study. Some previous studies have found a relation between the atmospheric pressure changes, windy days and SP incidence [12]. Meteorological changes not only cause SP but also certain other respiratory problems. Having born as a result of this interaction, cough plays a triggering role. Unlike literature data, our results suggested no effect of daily drops in atmospheric pressures on SP occurrence. Some studies have reported that temperature changes exert significant effect on SP incidence and our results were compatible with those observations [8,9]. This phenomenon may be explained by the effect of temperature on pressure [13,14]. Temperature and humidity readings that were found in significant relationship with SP occurrence in our study may be observed in stormy days with higher wind velocities [15,16]. Changes in air composition such as higher concentrations of ground ozone levels in addition to heat waves and extreme

Table 1. The meteorological variables on the days with versus without SP occurrence

Parameters	Days with SP Mean ± SD	Days without SP Mean ± SD	p
Minimum temperature ºC (min.)	10 ± 8.7	9.06 ± 8.6	0.037
Maximum temperature ºC (max.)	24.3 ± 11.5	22.9 ± 11.4	0.037
Temperature difference ºC (max-min)	14.2 ± 4.9	13.9 ± 5	0.231
Minimum atmospheric pressure (mbar)	932.8 ± 5.9	933.29 ± 5.97	0.182
Maximum atmospheric pressure (mbar)	936.34 ± 5.98	936.76 ± 5.87	0.205
Atmospheric pressure difference (mbar)	3.49 ± 1.62	3.46 ± 1.76	0.769
Total amount of precipitation (mm)	4.32 ± 6.12	4.95 ± 7.69	0.452
Wind velocity (m/s)	1.46 ± 0.69	1.4 ± 0.67	0.112
Mean atmospheric pressure (mbar)	934 ± 5.89	935 ± 5.83	0.195
Mean temperature ºC	17.28 ± 10.3	16 ± 10.2	0.034
Humidity (%)	49.9 ± 25.5	52.8 ± 25.4	0.044

SP: Spontaneous pneumothorax.

Table 2. Factors associated with accurence of pneumothorax in the logictic regression model

Factors	Sig. P	OR	95% C.I.
Min C°	0.185	1.038	0.98-1.09
Max P	0.580	1.017	0.95-1.07
Rainfall	0.464	0.987	0.95-1.02
Wind	0.700	1.079	0.73-1.59
Humidity	0.845	1.002	0.98-1.02

Variable(s) entered on equation: Min C^0: Minimum temperature, Max P: Maximum pressure, rainfall, wind, humidity.

meteorological events may fluctuate and cause respiratory diseases. High levels of ozone were found to be a precipitating factor in the damage of lung tissue elasticity and also be a factor in the rupture of blebs or bullae in occurrence of SP during spring season [17].

Bertolaccini et al. found that SP incidence was significantly affected by smoking and viral infection in addition to higher concentrations of environmental pollution and constant exposure to allergens [14]. For this purpose they evaluated meteorological variables and variables of the environmental pollution altogether. In that analysis, the daily mean maximum ozone and the daily minimum nitrogen dioxide (NO_2) were significantly related to SP occurrence. The mean amount of the particles causing daily environmental pollution and the daily minimum and maximum nitrogen dioxide (NO_2) were less important [14]. Although SP clustering due to environmental pollution is common, as stated by some publications, we did not evaluate the relationship between the industry-related environmental pollution and SP clustering since no such pollution was evident in our study. Many of changes in climate are reported to have negative effects on respiratory health and the frequency and severity of respiratory diseases. The effects of meteorological changes on respiratory diseases are still not well defined, and more studies addressing this topic are needed [18].

In conclusion, in this study we determined that the changes in the temperature readings and the humidity rates alter weather conditions, affecting SP incidence. Although we found some relationship between some meteorological variables and SP incidence, there is still a need for more comprehensive multicentric and prospective studies.

The authors declare that we did not have any financial relations/support concerning the study. We also state that we scientifically contributed to and took responsibility in the study and declare that there is no conflict of interest.

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REFERENCES

1. Laennec RTH. Traite´du diagnostic des maladies des poumons et du coeur. Tome Second, Paris: Brosson and Chaude, 1819. [CrossRef]
2. Light RW. Pneumothorax. In: Light RW (ed). Pleural diseases. 3rd ed. Baltimore: Williams & Wilkins 1995:242-77.
3. Henry M, Arnold T, Harvey J; Pleural Diseases Group, Standards of Care Committee, British Thoracic Society. BTS guidelines for the management of spontaneous pneumothorax. Thorax 2003;58:ii39-ii52. [CrossRef]
4. Gupta D, Hansell A, Nichols T, Duong T, Ayres JG, Strachan D. Epidemiology of pneumothorax in England. Thorax 2000;55:666-71. [CrossRef]
5. Fry WA, Paape K. Pneumothorax. In: Shields TW, LoCiceroIII J, Ponn RB, Rusch VW (eds). General thoracic surgery. 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2005:794-805.
6. Yazkan R, Han S. Pathophysiology, clinical evaluation and treatment options of spontaneous pneumothorax. Tuberk Toraks 2010;58:334-43. [CrossRef]
7. Ozpolat B, Gözübüyük A, Koçer B, Yazkan R, Dural K, Genç O. Meteorological conditions related to the onset of spontaneous pneumothorax. Tohoku J Exp Med 2009;217:329-34. [CrossRef]
8. Suarez-Varel MM, Martinez-Selva MI, Llopis-Gonzalez A, Martinez-Jimeno JL, Plaza-Valia P. Spontaneous pneumothorax related with climatic characteristics in the Valencia area (Spain). Eur J Epidemiol 2000;16:193-8. [CrossRef]
9. Bulajich B, Subotich D, Mandarich D, Kljajich RV, Gajich M. Influence of atmospheric pressure, outdoor temperature, and weather phases on the onset of spontaneous pneumothorax. Ann Epidemiol 2005;15:185-90. [CrossRef]
10. Bense L, Eklund G, Wiman LG. Smoking and the increased risk of contracting pneumothorax. Chest 1987;92:1009-12. [CrossRef]
11. Boulay F, Sisteron O, Chevallier Th, Blaive B. Predicatable mini-epidemics of spontaneous pneumothorax: haemoptysis too? Lancet 1998;351:522. [CrossRef]
12. Alifano M, Parri SNF, Bonfanti B, Abu Arab W, Passini A, Boaron M, et al. Atmospheric Pressure Influences the Risk of Pneumothorax* Beware of the Storm! Chest 2007;131:1877-82. [CrossRef]
13. Zhang GJ, Gao R, Fu JK, Jin X, Zhang Y, Wang Z. Climatic Conditions and the Onset of Primary Spontaneous Pneumothorax: An Investigation of the Influence of Solar Terms. Med Princ Pract 2012;21:345-9. [CrossRef]
14. Bertolaccini L, Alemanno L, Rocco G, Cassardo C. Air pollution, weather variations and primary spontaneous pneumothorax. J Thorac Dis 2010;2:9-15.
15. Chen CH, Kou YR, Chen CS, Lin HC. Seasonal variation in the incidence of spontaneous pneumothorax and its association with climate: A nationwide population-based study. Respirology 2010;15:296-302. [CrossRef]
16. Bozkurt S, Tokur M, Okumuş M, Kahraman H, Özkan F, Tabur A. Spontan pnömotoraks oluşumunda meteorolojik değişikliklerin rolü ve hastaların klinik özellikleri. Turk Gogus Kalp Damar 2013;21:95-9. [CrossRef]
17. Abul Y, Karakurt S, Bostanci K, Yuksel M, Eryuksel E, Evman S, et al. Spontaneous pneumothorax and ozone levels. Multidisciplinary Resp Med 2011:6:16-19. [CrossRef]
18. D'Amato G, Holgate ST, Ruby Pawankar R, Dennis K, Ledford D K, Lorenzo Cecchi L, et al. Meteorological conditions, climate change, new emerging factors, and asthma and related allergic disorders. A statement of the World Allergy Organization. World Allergy Organization Journal (2015) 8:25. [CrossRef]